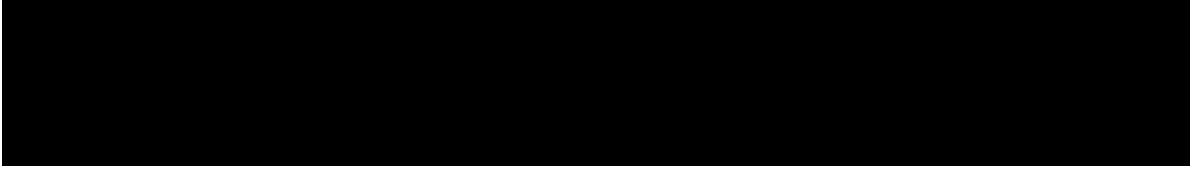# EXHIBIT 15

JEDEC STANDARD

DDR4 SDRAM

JESD79-4D

(Revision of JESD79-4C, JANUARY 2020)

JULY 2021

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

DDR4 SDRAM STANDARD

(From JEDEC Board Ballot JCB-21-07, formulated under the cognizance of the JC-42.3C Subcommittee on DRAM Memories.)

1   Scope

This document defines the DDR4 SDRAM specification, including features, functionalities, AC and DC characteristics, packages, and ball/signal assignments. The purpose of this Standard is to define the minimum set of requirements for JEDEC compliant 2 Gb through 16 Gb for x4, x8, and x16 DDR4 SDRAM devices. This standard was created based on the DDR3 standards (JESD79-3) and some aspects of the DDR and DDR2 standards (JESD79, JESD79-2).

Each aspect of the changes for DDR4 SDRAM operation were considered and approved by committee ballot(s). The accumulation of these ballots were then incorporated to prepare this JESD79-4 specifications, replacing whole sections and incorporating the changes into Functional Description and Operation.

2   DDR4 SDRAM Package Pinout and Addressing

2.1   DDR4 SDRAM Row for X4, X8 and X16

The DDR4 SDRAM x4/x8 component will have 13 electrical rows of balls. Electrical is defined as rows that contain signal ball or power/ground balls. There may be additional rows of inactive balls for mechanical support.

The DDR4 SDRAM x16 component will have 16 electrical rows of balls. There may be additional rows of inactive balls for mechanical support.

2.2   DDR4 SDRAM Ball Pitch

The DDR4 SDRAM component will use a ball pitch of 0.8 mm by 0.8 mm.
The number of depopulated columns is 3.

2.3   DDR4 SDRAM Columns for X4, X8, and X16

The DDR4 SDRAM x4/x8 and x16 component will have 6 electrical columns of balls in 2 sets of 3 columns.
There will be columns between the electrical columns where there are no balls populated. The number of these columns is 3.
Electrical is defined as columns that contain signal ball or power/ground balls. There may be additional columns of inactive balls for mechanical support.